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Spectrally resolved flares in the quiescent black hole V404 Cyg

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Abstract. We present a spectrophotometric study of short-term optical variability in the quiescent black hole X-ray transient V404 Cyg focusing on two nights of Hα spectroscopy. We find significant variability, with both the Hα line and the continuum varying in a correlated way. This includes both dramatic flares lasting a few hours in which the line flux nearly doubles and lower-level flickering. The strongest flares involve development of asymmetry in the line profile, with the red wing usually strongest independent of orbital phase. Based on the line profile changes during the flares, we conclude that the most likely origin for the variability is variable photoionisation by the central source.

The quiescent black hole binary V404 Cyg has long been known to exhibit significant variability in quiescent optical, IR, X-ray and radio fluxes (see Hynes et al. (2002) for summary and references). In particular, Hα line profiles change significantly on short timescales (Casares & Charles 1992; Casares et al. 1993). Understanding these variations is important as the properties of the variability can yield clues about the nature of the quiescent accretion flow and provide an observational test of models for this flow. To further investigate this behaviour, in 1999 July we obtained red spectroscopy at high time-resolution so as to reveal the spectral signature of the short-term variability. We obtained simultaneous photometry to ensure a reliable flux calibration; hence we can accurately study both line and continuum variations. The low spectral resolution also provides us with kinematic resolution of emission line variations. A thorough analysis of these data is given in Hynes et al. (2002); here we summarise some of the key results.

We find significant line and continuum variability; the Hα line is particularly dramatic showing variations of a factor of two in flux over a few hours, much less than the 6.5 day orbital period. The line and continuum variations generally appear well correlated with no detectable lag between them (< 4 min).

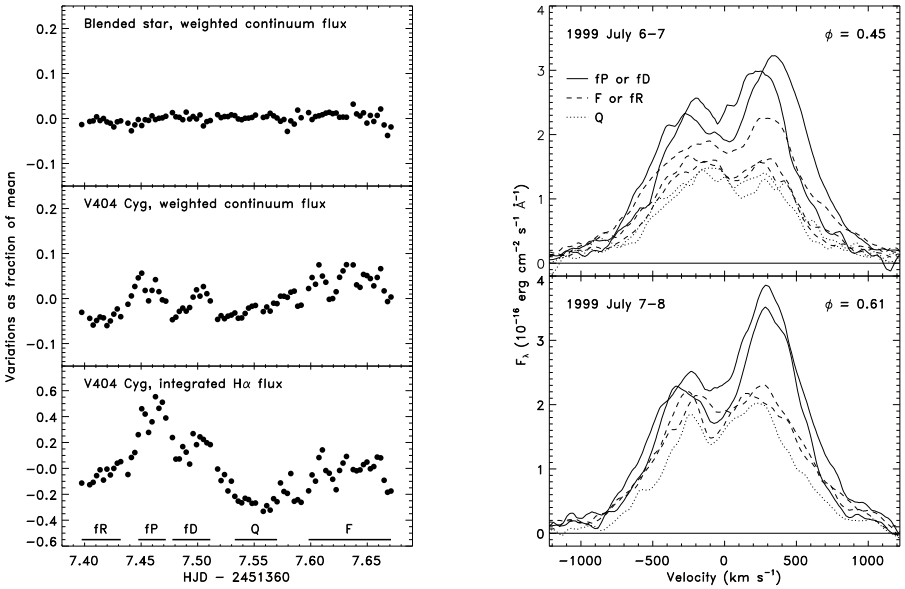

Figure 1. Left: Line and continuum lightcurves from 1999 July 7-8. Right: Line profiles for different states from both nights. The abbreviations are Q = quiescent; faintest state, F = flickering state, fR, fP and fD = flare rise, peak and decline respectively.

During the large flares, significant profile changes are seen. A response is seen across the whole line profile and the excess light has a double peaked profile, suggesting that the whole disc is involved. Interestingly the excess light is not symmetric and the red wing is usually significantly stronger (in archival data as well as that presented here), independent of orbital phase. This suggests that it does not indicate the kinematics of a brighter region but that some other effect, perhaps vertical motion or absorption of the blue wing by approaching material, is at play.

It seems likely that the Hα emission is driven by X-ray flares; hence the whole disc can be affected on short timescales. A wind driven by the flares could then be responsible for absorbing the blue wing of the profile.

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